

CASE NARRATIVE

Full Tier III sampling and analysis procedures were conducted in accordance with the *Sampling and Analysis Plan (SAP), Alamitos Bay Marina Dredged Material Evaluation* (Weston Solutions 2007). Samples were collected from the Alamitos Bay Marina and LA-2 Reference site on 2 - 5 April 2007. Testing was conducted with the reference sample and composites of the project samples following guidance in *Evaluation of Dredged Material Proposed for Ocean Disposal* (USEPA/USACE 1991) otherwise known as the Ocean Testing Manual (OTM); *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual* (USEPA/USACE 1998), otherwise known as the Inland Testing Manual (ITM); and the *Regional Implementation Agreement (RIA) for the Evaluation of Dredged Material for Ocean Disposal* (USACE/USEPA 1993). After collection, samples were stored in a secured area at $4 \pm 2^\circ\text{C}$. Samples were processed, and then shipped to the analytical laboratories in coolers on blue ice. All chemical analyses and bioassays were performed within required holding times from sample collection. Initial BP testing was also initiated within required holding times. However, following a laboratory error involving the inadvertent compositing of replicate tissue samples, BP testing exposures were re-initiated 11 July 2007. Composite tissue analysis results are reported in this report, and the retest results will be reported in an addendum to this document.

The analytical chemistry results showed that metals associated with urban run-off (i.e. copper, lead, mercury and zinc) were detected at nominally elevated concentrations across all docking basins. The only metal detected at a level significantly different from other sample areas was mercury measured in the Basin 1 sample at 0.8 mg/kg. Organic constituents, with the exception of DDT and a few PAH compounds, were below acceptable levels of detection. Σ DDT was detected at concentrations consistent throughout all docking basins, but at relatively low levels (up to 13.8 $\mu\text{g/kg}$). The total PAH concentrations were substantially lower than levels of ecological concern. The only significant toxicity observed among the five bioassays performed with the Alamitos Bay sediments was with the solid phase organism, *Rhepoxinius abronius*. The reduction in survival observed with this organism was relatively consistent throughout all basins, with a mean survival rate of 33.6% (52.4% lower than the LA-2 treatment survival). Because there were no other significant effects and no correlation with sediment contaminants, the causal agent of the observed toxicity can not be identified with the available data. If follow-up testing is performed to address the issues of elevated mercury concentrations in the Basin 1 sample and the reduction in *Rhepoxinius* survival across all docking basins, the results will be provided a supplement to this report. Table 1 summarizes sample identifications and participating laboratories involved with sample collection and analysis.

TABLE 1
Sample Collection and Analysis Summary

SAMPLE IDENTIFICATION			SAMPLING AND ANALYSIS DELEGATION			
Individual Core I.D.s	Sample Composite I.D.	WESTON Laboratory I.D.	Sample Collection & Project Management	Sediment and Tissue Chemical Analysis	BP Testing Exposures	TOC, Grain Size & Bioassays
LA-2 Reference	LA-2	C070411.01	Weston Solutions Oakland, CA	EnviroMatrix Analytical San Diego, CA	Weston Solutions Port Gamble, WA	Weston Solutions Carlsbad, CA
B1-1,2,3,4,5	B1	C070411.02				
B2-1,2,3,4,5,6	B2	C070411.03				
B1-1,2,3,4	B3	C070411.04				
B1-1,2,3,4,5	B4	C070411.05				
B1-1,2,3,4	B5	C070411.06				
B1-1,2,3,4,5	B6	C070411.07				
B1-1,2,3	B7	C070411.08				

1 INTRODUCTION

As part of a 6 to 10 year phased construction program aimed at rehabilitating berthing slips and access features throughout the Alamitos Bay Marina (AB Marina), the City of Long Beach is proposing to dredge shoaled material from within all seven of the Marina's docking basins. The proposed disposal site for all phases of this project is the U.S. Environmental Protection Agency (USEPA) designated offshore disposal site, LA-2. The AB Marina is located in the southeastern corner of Los Angeles County at the intersection of Pacific Coast Highway and Second Street, just north of the San Gabriel River. A vicinity map depicting the relative locations of the proposed project location and sediment disposal site is provided as Figure 1.

The proposed dredging episode involves the removal of accumulated sediment in order to return each of the Marina's seven basins to the previously permitted depth that will allow unencumbered maneuvering of recreational vessels. The AB Marina construction program involves dredging Basins 2 through 7 to a target depth of 10 feet below Mean Lower Low Water (-10 ft MLLW). Basin 1 will be bisected and deepened to two different target depths: -12 and -15 ft MLLW. The estimated total volume of dredged material to be removed from the seven basins is 117,000 cubic yards (CY). Including an additional two feet of overdredge, the total volume represented by the proposed sampling depth is 287,000 CY. Dredge volumes for individual AB Marina docking basins are provided in Table 2. A project area map showing all seven basins is provided as Figure 2.

TABLE 2
Summary Individual Basin Dredge Volumes

Sample Area	Estimated Volume to Target Depth (CY)	1-ft Overdredge Volume (CY)	2-ft Overdredge Volume (CY)	Totals
Basin 1	28,400	12,400	12,900	53,700
Basin 2	37,700	21,200	31,000	89,900
Basin 3	19,200	13,200	23,500	55,900
Basin 4	19,600	14,700	31,000	65,300
Basin 5	1,320	1,100	1,450	3,870
Basin 6N	7,800	1,950	2,500	12,250
Basin 6S	2,000	900	1,200	4,100
Basin 7	1,000	500	600	2,100
Total	117,020	65,950	104,150	287,120

In accordance with the SAP, all material proposed for dredging including two feet of overdredge was evaluated for ocean disposal suitability following federal and regional guidelines outlined in the Ocean Testing Manual (USEPA/ACE 1991) and the Draft Regional Implementation Agreement (RIA) for the Evaluation of Dredged Material for Ocean Dumping (USACE/EPA 1993). Results of the sampling and analysis procedures performed under this study are assessed to determine whether sediment from the AB Marina will be suitable for aquatic disposal at LA-2, and to provide baseline sediment quality data for making decisions on additional testing requirements during the later years of the marina rehabilitation process.

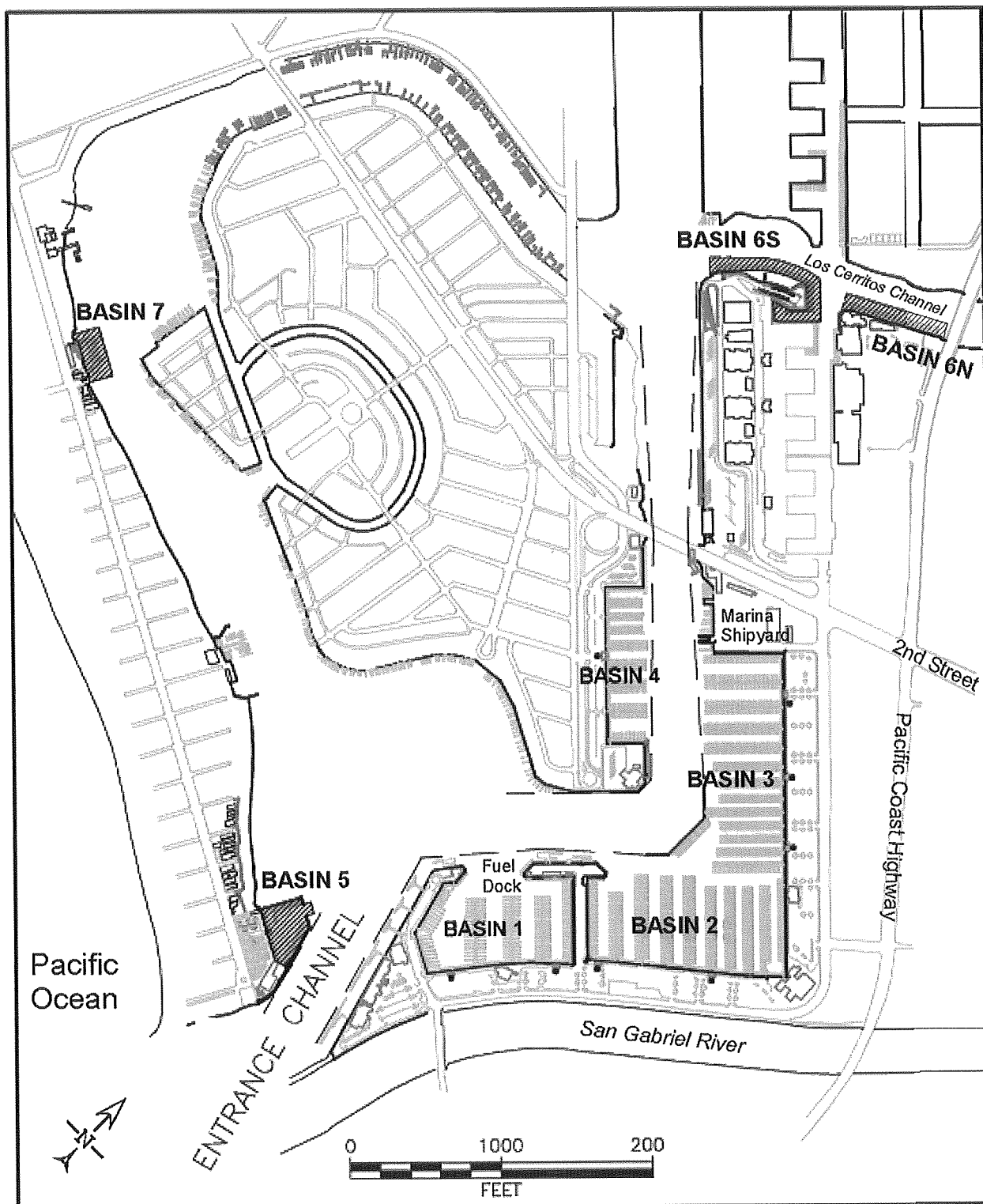


Figure 2. Project Area: Alamitos Bay Marina Docking Basins

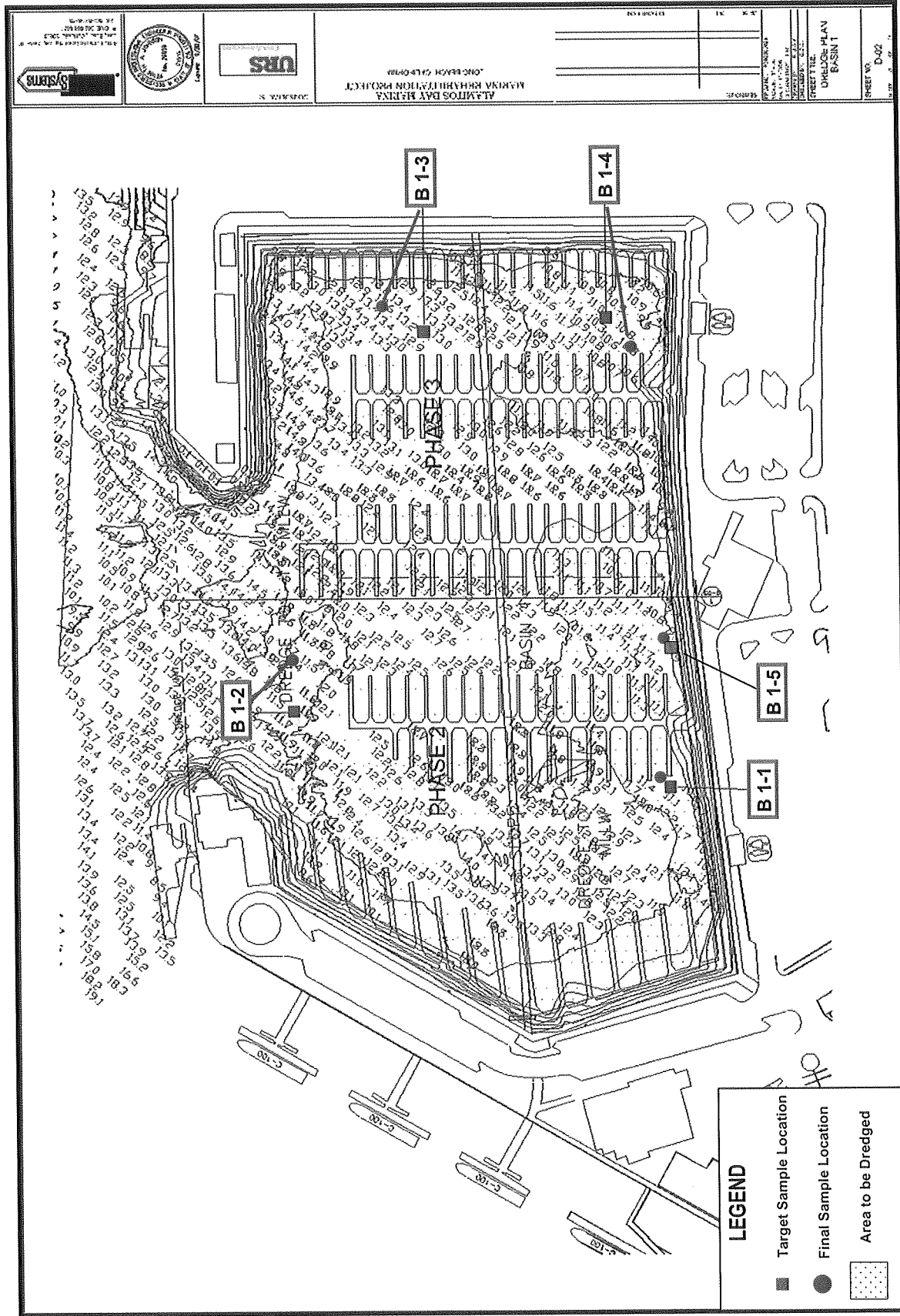
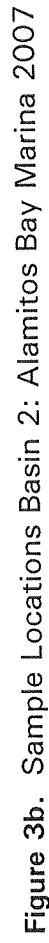


Figure 3a. Sample Locations Basin 1: Alamitos Bay Marina 2007



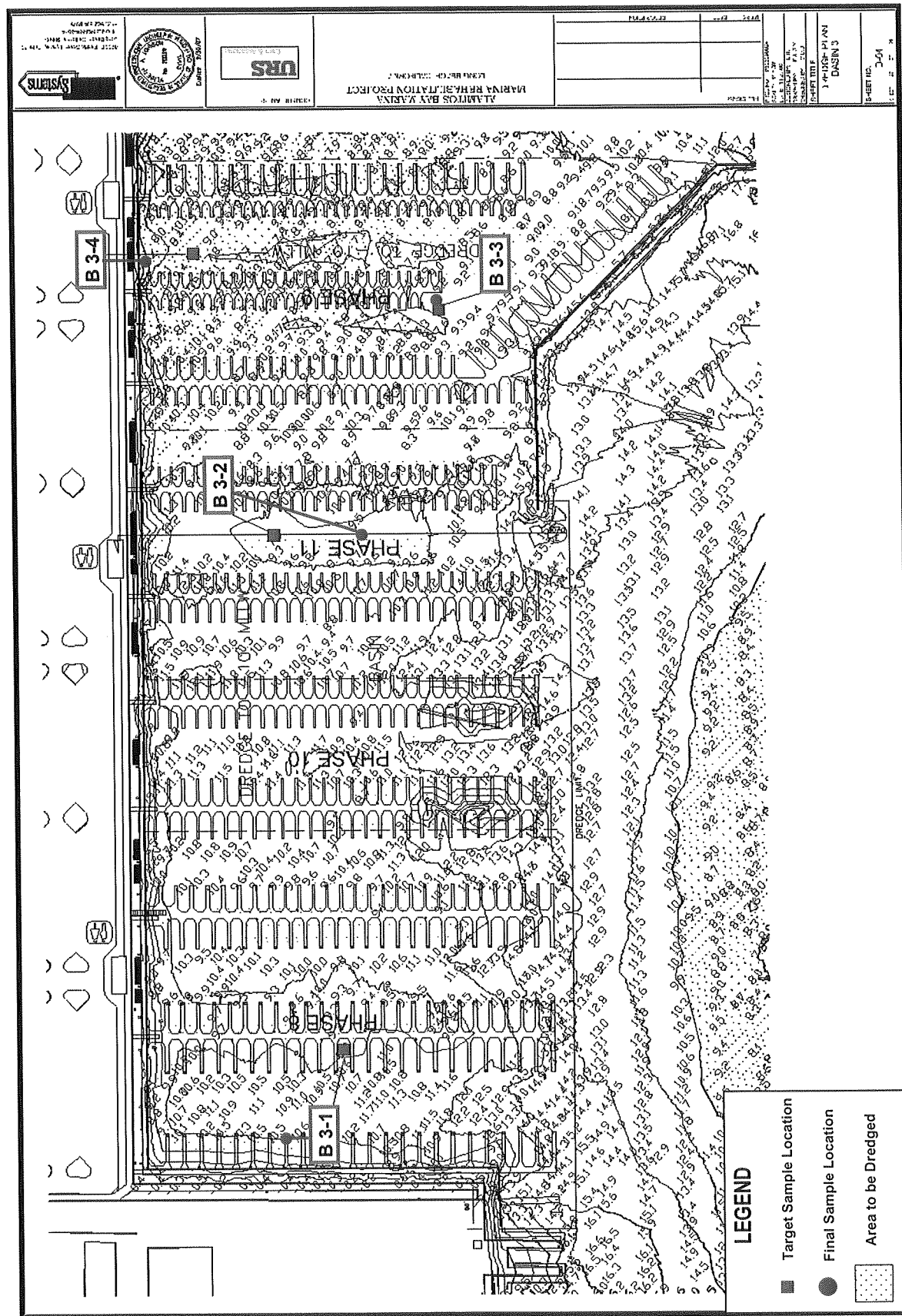


Figure 3c. Sample Locations Basin 3: Alamitos Bay Marina 2007

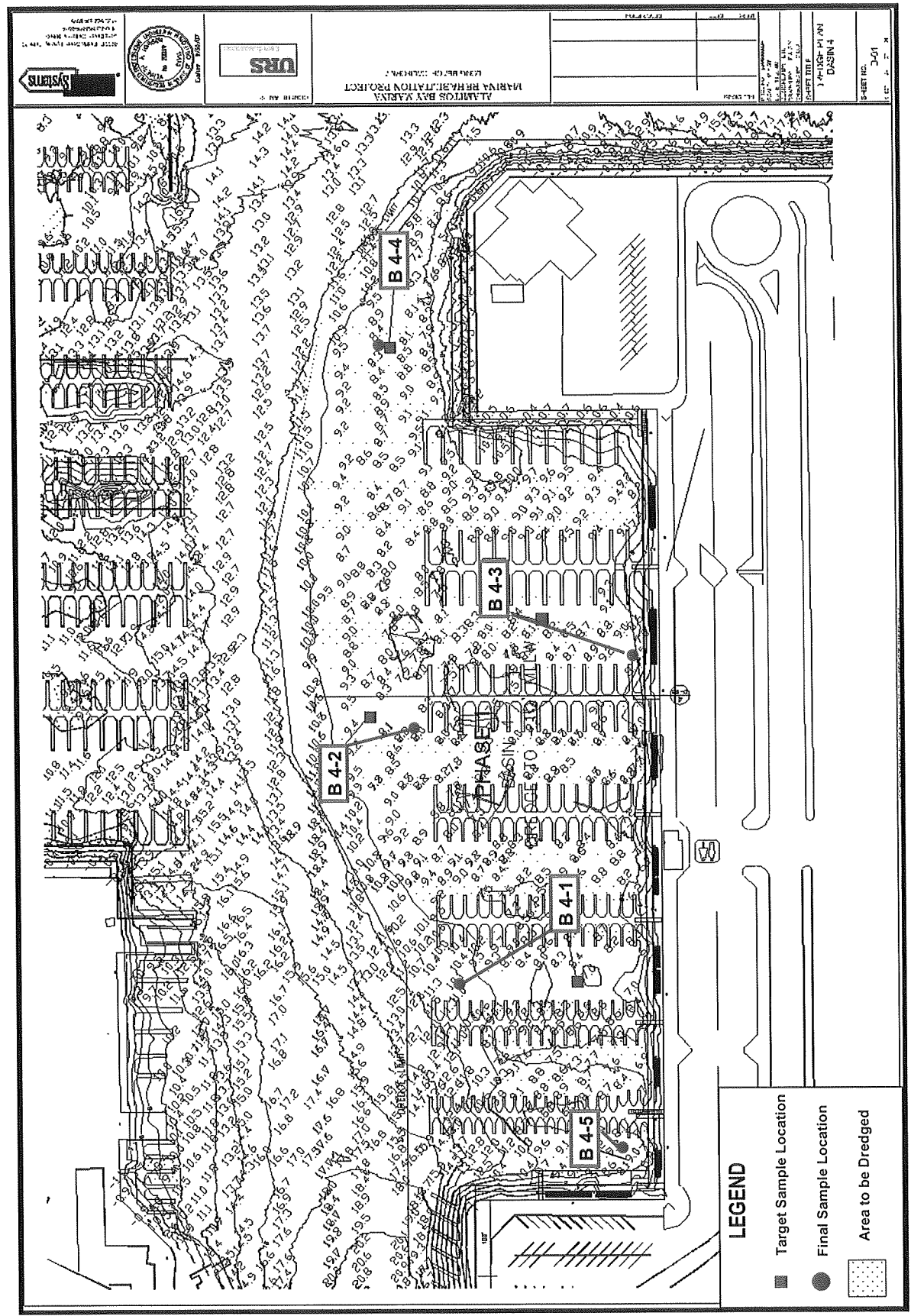


Figure 3d. Sample Locations Basin 4: Alamitos Bay Marina 2007

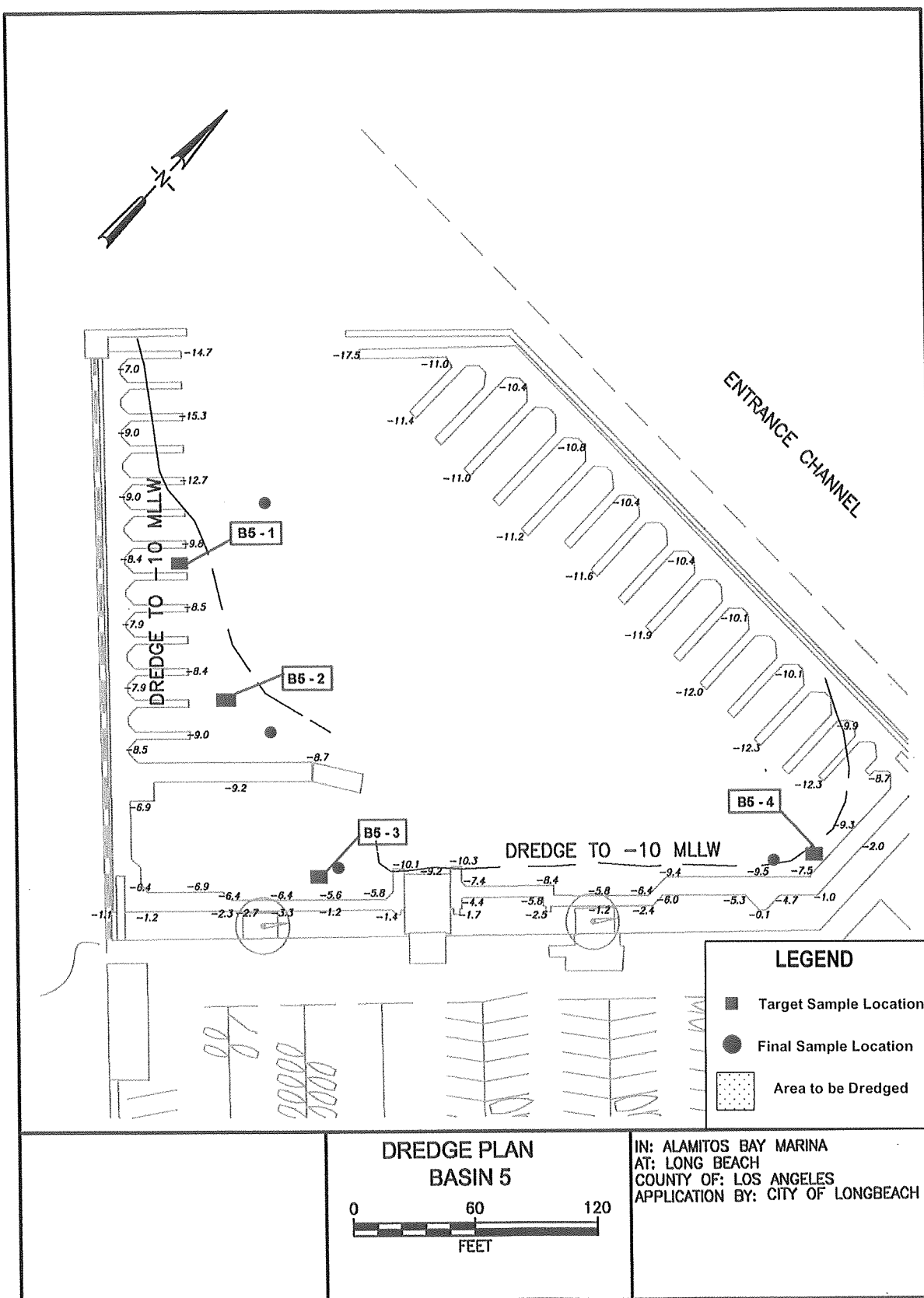


Figure 3e. Sample Locations Basin 5: Alamitos Bay Marina 2007

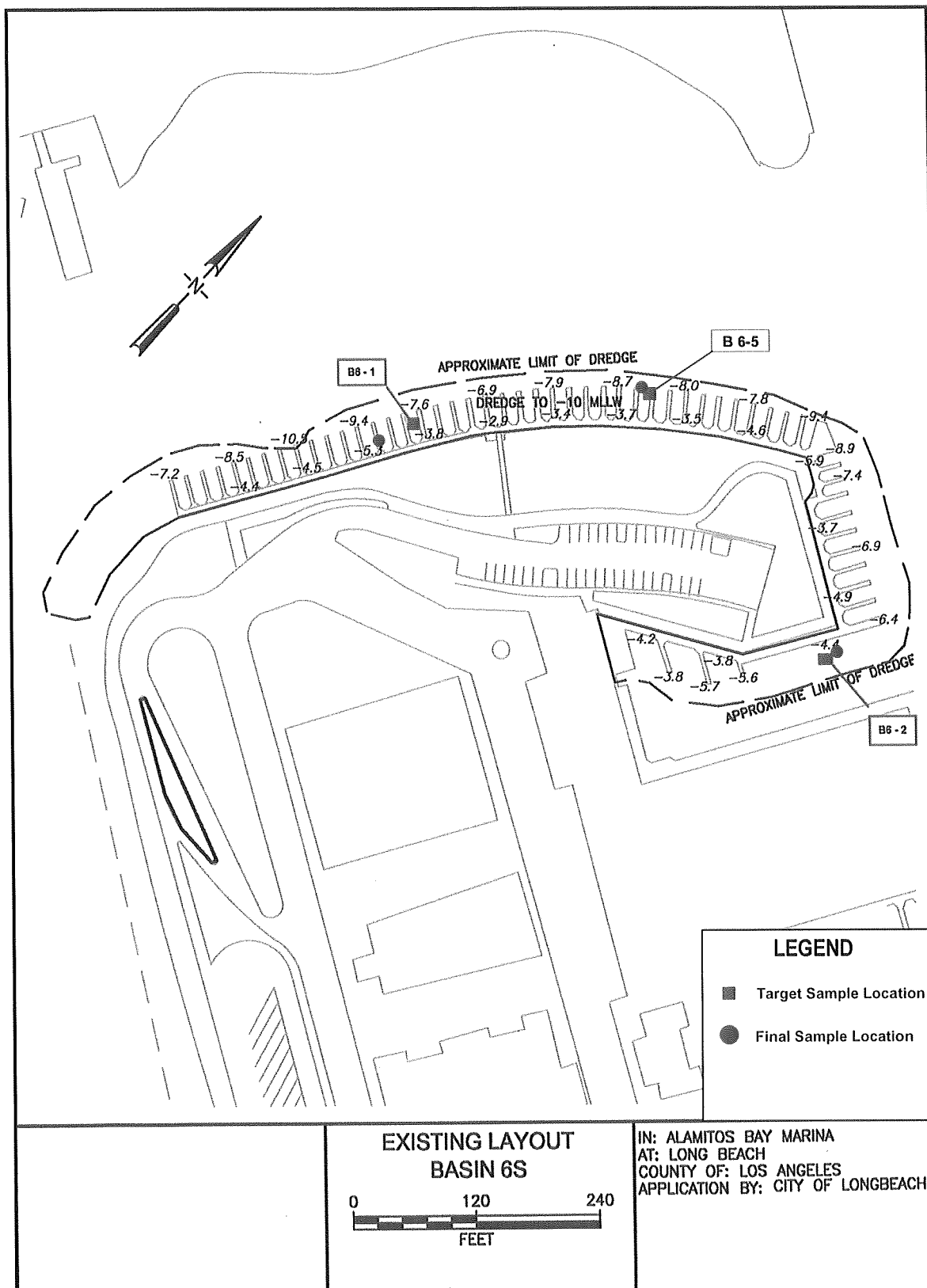


Figure 3f. Sample Locations Basin 6S: Alamitos Bay Marina 2007

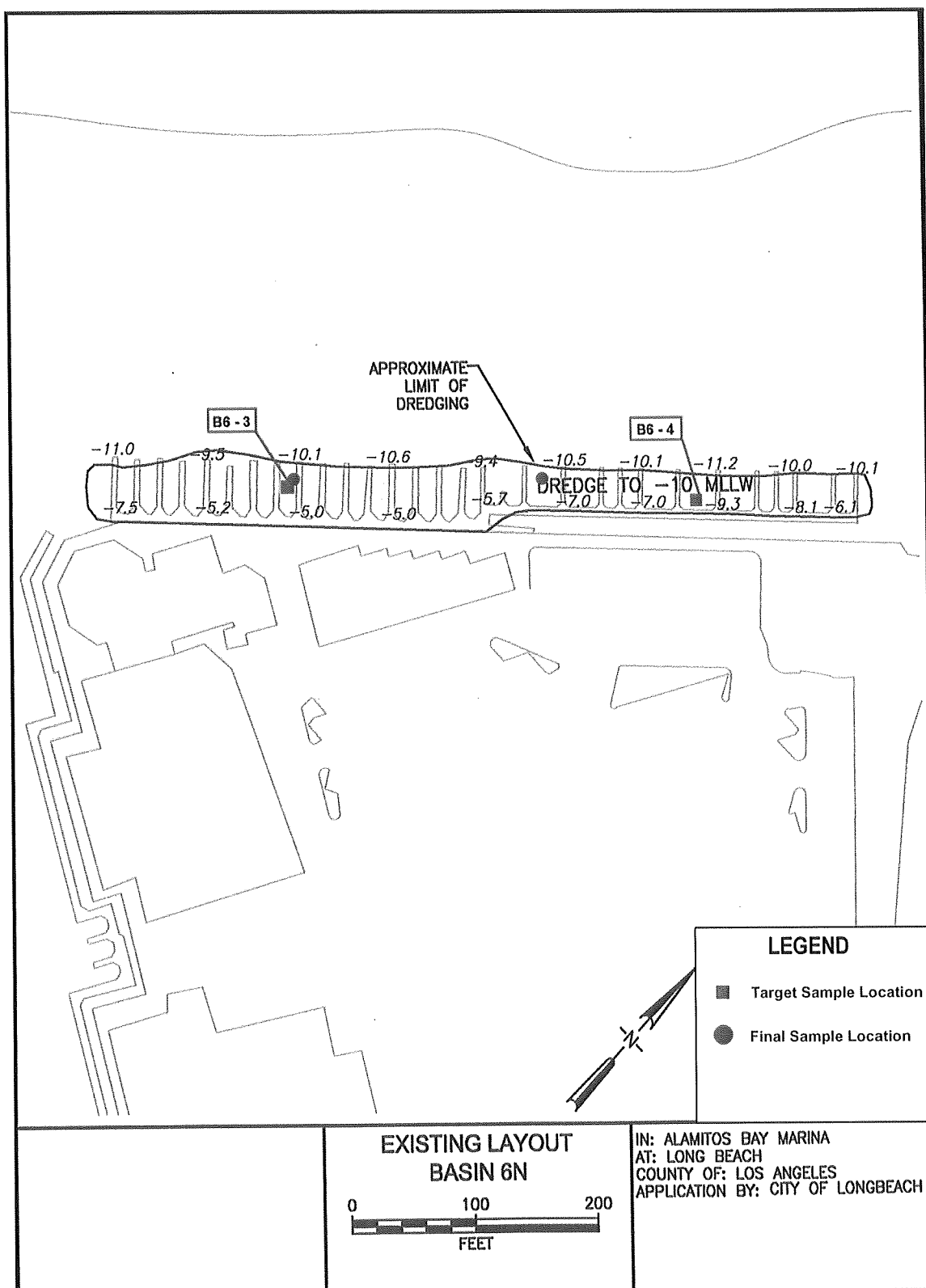


Figure 3g. Sample Locations Basin 6N: Alamitos Bay Marina 2007

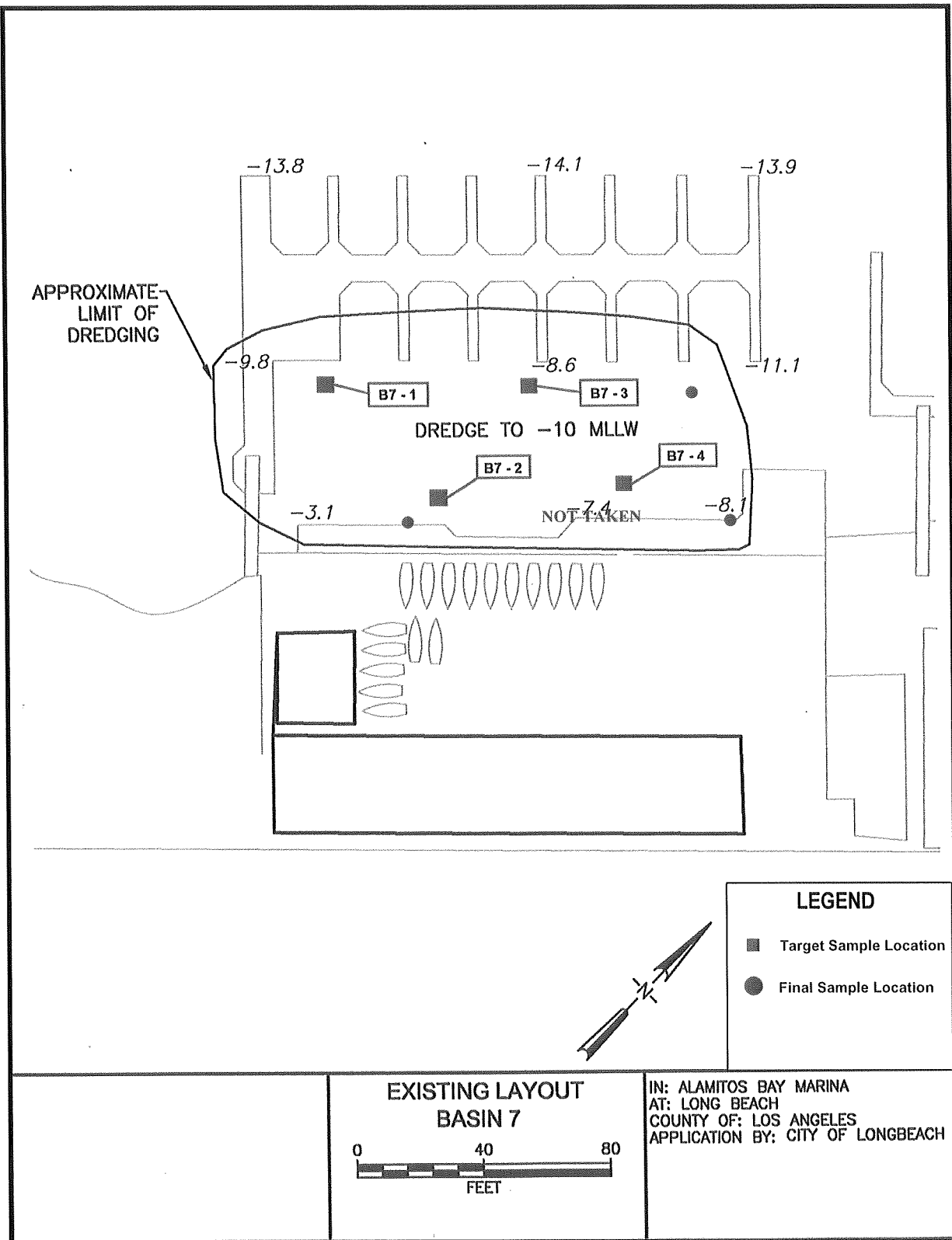


Figure 3h. Sample Locations Basin 7: Alamitos Bay Marina 2007

TABLE 5
Alamitos Bay Marina Core Log

Sample Station	Station Coordinates (NAD 83)	Mudline Depth (-ft MLLW)		Target Sample Depth* (-ft MLLW)	Target Core Length (ft)	Core Length Retrieved (ft)
		Expected	Actual			
B1 - 1	33°44.910N by 118°06.835W	11.1	10.9	14	3.1	3.3
B1 - 2	33°44.985N by 118°06.868W	11.8	11.7	17	5.3	5.3
B1 - 3	33°45.033N by 118°06.796W	13.2	13.5	17	3.5	3.5
B1 - 4	33°44.975N by 118°06.749W	10.9	11.0	14	3.0	4.5
B1 - 5	33°44.927N by 118°06.806W	10.8	9.8	14	4.2	4.5
B2 - 1	33°45.012N by 118°06.707W	7.4	9.1	12	2.9	4.3
B2 - 2	33°45.107N by 118°06.669W	7.0	9.4	12	2.6	3.5
B2 - 3	Not Sampled	8.0	NA	12	NA	NA
B2 - 4	33°45.177N by 118°06.610W	7.1	9.8	12	2.2	3.0
B2 - 5	33°45.063N by 118°06.706W	7.9	9.5	12	2.5	4.0
B2 - 6	33°45.077N by 118°06.601W	7.3	9.5	12	2.5	3.0
B3 - 1	33°45.363N by 118°06.818W	9.2	9.0	12	3.0	4.0
B3 - 2	33°45.266N by 118°06.722W	7.9	9.8	12	2.2	3.5
B3 - 3	33°45.205N by 118°06.705W	7.5	9.0	12	3.0	3.0
B3 - 4	33°45.248N by 118°06.642W	7.8	8.7	12	3.3	4.5
B4 - 1	33°45.286N by 118°06.931W	8.5	9.4	12	2.6	4.0
B4 - 2	33°45.270N by 118°06.898W	8.3	9.4	12	2.6	4.0
B4 - 3	33°45.234N by 118°06.919W	8.6	8.7	12	3.3	5.0
B4 - 4	33°45.228N by 118°06.832W	8.4	10.0	12	2.0	2.5
B4 - 5	33°45.304N by 118°06.994W	8.4	8.7	12	3.3	4.5
B5 - 1	33°44.821N by 118°07.046W	8.9	9.3	12	2.7	3.8
B5 - 2	33°44.808N by 118°07.055W	8.5	9.5	12	2.5	2.9
B5 - 3	33°44.796N by 118°07.057W	7.8	8.5	12	3.5	4.4
B5 - 4	33°44.779N by 118°07.020W	7.8	9.6	12	2.4	2.7
B6 - 3	33°45.735N by 118°07.006W	7.5	8.5	12	5.5	5.5
B6 - 4	33°45.752N by 118°06.966W	8.2	8.9	12	3.1	4.0
B6 - 1	33°45.678N by 118°07.170W	5.2	7.5	12	4.5	4.4
B6 - 2	33°45.683N by 118°07.074W	5.0	6.8	12	5.2	6.0
B6 - 5	33°45.706N by 118°07.128W	5.0	7.7	12	4.3	4.3
B7 - 1	33°45.127N by 118°07.738W	7.5	8.5	12	3.5	3.4
B7 - 2	33°45.129N by 118°07.722W	7.9	8.5	12	3.5	4.2
B7 - 3	33°45.120N by 118°07.722W	7.9	8.7	12	3.3	3.3
B7 - 4	Not Sampled	NA	NA	12	NA	NA

*Target core length includes two-foot overdredge depth tolerance

TABLE 8
Bioassay Testing Performed on AB Marina Project Sediment

Type of Organism	Taxon	Project Materials	Native Control Sediment	Reference Sediment	Reference Toxicant	Ammonia Reference Toxicant
Suspended Phase Particulate Test (SPP Test)						
Bivalve larvae	<i>Mytilus edulis</i>	X	X	NA	X	X
Mysid shrimp	<i>Mysidopsis bahia</i>	X	X	NA	X	X
Fish	<i>Menidia beryllina</i>	X	X	NA	X	X
Solid Phase Test (SP Test)						
Amphipod	<i>Rhepoxinius abronius</i>	X	X	X	X	X
Polychaete	<i>Neanthes arenaceodentata</i>	X	X	X	X	X
Bioaccumulation Potential Test (BP Test)						
Mollusk	<i>Macoma nasuta</i>	X	X	X	NA	NA
Polychaete	<i>Nephtys caecoides</i>	X	X	X	NA	NA

NA: Not applicable

2.3.1.1 *Mytilus edulis* Test

Table 9 summarizes bioassay procedures and organism data for the *M. edulis* SPP test of AB Marina sediments. Bivalve larvae bioassay methods are from ASTM E724-98 (ASTM, 2005a). Three concentrations of the elutriate (100%, 50% and 10%) and a site water control were tested. Adult *M. edulis* were obtained from Carlsbad Aquafarms of Carlsbad, CA. Spawning was induced by temperature manipulation. Unfertilized eggs were separated from debris by filtering the suspension through an 80-um nitex mesh screen. Released gametes were then combined in individual containers of filtered seawater and allowed to fertilize for up to two hours under gentle aeration. Embryo stock density was estimated by counting an aliquot of dilute stock concentrate. Equal volumes of stock were then added to each test chamber to achieve an estimated density of 15-30 embryos/ml. The test was run using five replicates for each treatment and control at $16 \pm 2^\circ \text{C}$ under a 16-hr light: 8-hr dark photoperiod. Temperature, pH, dissolved oxygen (DO), and salinity were measured at test initiation and termination. At 48 hours each replicate was preserved using a 0.25 mL formaldehyde solution. All larvae in each replicate were counted in a Sedgwick-Rafter cell to determine the total number of normally and abnormally developed larvae. The test acceptability criterion is $\geq 70\%$ control survival (normal embryos based on initial inoculation). A reference toxicant test was conducted using copper sulfate as a positive control with concentrations of 2.5, 5.0, 10, 20, and 40 $\mu\text{g Cu}^{2+}/\text{L}$.

2.3.1.2 *Mysidopsis bahia* Test

Table 10 summarizes bioassay procedures and organism data for the *M. bahia* SPP test of the AB Marina sediments. Three elutriate concentrations (100%, 50% and 10%) and a site water control were tested. The *M. bahia* bioassay method is described in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (USEPA 2002). Three-day-old mysids were obtained from Aquatic Biosystems of Fort Collins, CO. Five replicates containing 500 mL of the three elutriate concentrations in 1-L plastic chambers were used, each containing 10 mysids. The test was conducted at 20°C under a 16-hr light: 8-hr dark photoperiod. The organisms were fed twice daily (< 24 -hour-old *Artemia nauplii*). Water quality measurements including salinity, DO, pH, and temperature were recorded daily for one replicate from each concentration, and measured in all replicates at test termination. Survival was recorded daily. Test acceptability criterion for the test is $\geq 90\%$ mean control survival. A reference toxicant test was conducted using copper chloride with concentrations of 62.5, 125, 250, 500, and 1,000 $\mu\text{g Cu}^{2+}/\text{L}$ to measure the relative sensitivity of the test organisms.

TABLE 15

Results of Chemical and Physical Analyses of Alamitos Bay Marina Sediment

Analyte	Sample Identification							LA-2	ER-L	ER-M
	B1	B2	B3	B4	B5	B6	B7			
Conventionals										
Grain Size (%)										
Sand	19.10	22.62	36.85	19.63	20.74	25.39	42.52	43.83	NA	NA
Clay	30.10	22.17	17.27	22.18	26.70	27.40	24.18	11.38	NA	NA
Silt	50.49	54.07	44.85	57.88	52.31	45.97	27.29	44.59	NA	NA
Total Organic Carbon (%)	1.17	1.20	0.79	1.14	1.33	1.20	1.41	0.45	NA	NA
Total Solids (%)	57.2	63.1	69.0	65.4	56.6	56.9	59.6	68.2	NA	NA
Soluble Sulfides (mg/kg)	<0.87	<0.79	<0.72	<0.76	<0.88	<0.88	3.05	<0.73	NA	NA
Total Sulfides (mg/kg)	<4.4	<4.0	<3.6	<3.8	<4.4	<4.4	<4.2	<3.7	NA	NA
Metals (mg/kg)										
As	8.98	6.05	5.50	6.22	7.33	6.65	7.10	3.59	8.2	70.0
Cd	0.664	0.747	0.601	0.855	0.901	1.13	0.558	0.220	1.2	9.6
Cr	47.8	41.5	34.7	41.5	50.8	49.9	39.1	28.7	81.0	370
Cu	60.1	49.2	44.3	52.3	56.0	76.2	54.6	9.60	34.0	270
Pb	71.0	72.1	54.8	85.0	97.9	70.9	58.8	6.96	46.7	218
Hg	0.83	0.36	0.36	0.29	.031	0.18	0.28	0.04	0.2	0.71
Ni	22.5	18.9	17.6	20.2	22.7	22.4	18.6	13.1	20.9	51.6
Ag	0.33	0.34	0.23	0.35	0.46	0.58	0.50	ND	1.0	3.7
Zn	148	135	102	204	155	213	136	50.8	150	410
PAHs (ug/kg)										
Acenaphthene	<6.29	<5.71	<5.22	<5.50	<6.36	<6.33	<6.04	<5.28	NA	NA
Acenaphthylene	<8.18	<7.42	<6.78	<7.16	<8.27	<8.22	<7.85	<6.86	NA	NA
Anthracene	<11.0	<9.98	<9.13	<9.63	<11.1	<11.1	<10.6	<9.24	NA	NA
Benzo (a) anthracene	<11.7	<10.6	<9.67	11.1	<11.8	<11.7	20.5	<9.78	NA	NA
Benzo (b) fluoranthene	<15.5	<14.1	<12.9	<13.6	<15.7	<15.6	20.6	<13.0	NA	NA
Benzo (k) fluoranthene	<12.0	<10.8	<9.91	<10.5	<12.1	<12.0	11.5	<10.0	NA	NA
Benzo (ghi) perylene	<17.0	<15.4	<14.1	<14.9	<17.2	<17.1	<16.3	<14.3	NA	NA
Benzo (a) pyrene	<12.9	<11.7	<10.7	<11.3	<13.0	<13.0	14.9	<10.8	NA	NA
Chrysene	<6.92	6.78	<5.74	8.24	7.46	<6.96	17.1	<5.81	NA	NA
Dibenz (ah) anthracene	<16.0	<14.5	<13.3	<14.0	<16.2	<16.1	<15.4	<13.5	NA	NA
Fluoranthene	<10.1	10.0	<8.35	13.0	13.0	<10.1	25.2	<8.45	NA	NA
Fluorene	<8.18	<7.42	<6.78	<7.16	<8.27	<8.22	<7.85	<6.86	NA	NA
Indeno (1,2,3-cd) pyrene	<17.5	<15.8	<14.5	<15.3	<17.7	<17.6	<16.8	<14.7	NA	NA
Naphthalene	<3.34	<3.03	<2.77	<2.92	<3.37	<3.36	<3.20	<2.80	NA	NA
Phenanthrene	<7.33	<6.64	<6.07	<6.41	7.83	<7.36	7.75	<6.14	NA	NA
Pyrene	<10.6	11.0	<8.81	14.1	13.8	<10.7	24.1	<8.91	NA	NA
Total Detected LMW PAH	ND	ND	ND	ND	7.83	ND	7.75	ND	NA	NA
Total LMW PAH*	<11.0	<9.96	<9.13	<9.63	<11.1	<11.1	<10.6	<9.24	NA	NA
Total Detected HMW PAH	ND	17.78	ND	46.4	34.35	ND	122.25	ND	NA	NA
Total HMW PAH*	<17.5	17.78	<14.5	46.4	34.35	<17.6	122.25	<14.7	NA	NA
Total Detected PAH	ND	17.78	ND	46.4	42.1	ND	130	ND	NA	NA
Total PAH*	<17.5	17.78	<14.5	46.4	42.1	<17.6	130	<14.7	4022	44792

Italicized analytes indicate LMW PAHs.

< Indicates concentrations are less than the corresponding method detection limit (MDL)

ER-L = Effects Range- Low: Lower tenth percentile concentration of screened sediment toxicity data, at which toxicity may begin

ER-M = Effects Range-Median: Median concentration of a compilation of toxic samples. (Long 1995)

*Total=Detected+Undetected at the achieved MDL.

TABLE 15 (CONT.)

Results of Chemical and Physical Analyses of Alamitos Marina Sediment

Analyte	Sample Identification							LA-2	ER-L	ER-M
	B1	B2	B3	B4	B5	B6	B7			
PCB Aroclors (ug/kg)										
1016	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1221	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1232	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1242	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1248	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1254	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1260	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
Total	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	22.7	NA
Pesticides (ug/kg)										
Aldrin	<0.91	<0.83	<0.76	<0.80	<0.92	<0.92	<0.88	<0.77	NA	NA
Alpha-BHC	<1.75	<1.58	<1.45	<1.53	<1.77	<1.76	<1.68	<1.47	NA	NA
Beta-BHC	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
Gamma-BHC	<1.10	<1.00	<0.91	<0.96	<1.11	<1.11	<1.06	<0.92	NA	NA
Delta-BHC	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
Chlordane	<4.16	<3.77	<3.45	<3.64	<4.20	<4.18	<3.99	<3.49	NA	NA
2,4-DDD	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
4,4-DDD	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
2,4 DDE	<0.94	<0.86	<0.86	<0.83	<0.95	<0.95	<0.91	<0.79	NA	NA
4,4 DDE	13.5	11.7	13.5	13.8	12.5	6.77	7.26	4.16	NA	NA
2,4 DDT	<1.75	<1.58	<1.45	<1.53	<1.77	<1.76	<1.68	<1.47	NA	NA
4,4 DDT	<17.5	<15.8	<14.5	<15.3	<17.7	<17.6	<16.8	<14.7	NA	NA
Total DDT	13.5	11.7	13.5	13.8	12.5	6.77	7.26	4.16	1.6	46.1
Dieldrin	<1.14	<1.03	<0.94	<0.99	<1.15	<1.14	<1.09	<0.95	NA	NA
Endosulfan I	<1.43	<1.30	<1.19	<1.25	<1.45	<1.44	<1.38	<1.20	NA	NA
Endosulfan II	<1.49	<1.35	<1.23	<1.30	<1.50	<1.49	<1.43	<1.25	NA	NA
Endosulfan sulfate	<1.26	<1.14	<1.04	<1.10	<1.27	<1.27	<1.21	<1.06	NA	NA
Endrin	<1.33	<1.20	<1.10	<1.16	<1.34	<1.34	<1.28	<1.11	NA	NA
Endrin aldehyde	<1.42	<1.28	<1.17	<1.24	<1.43	<1.42	<1.36	<1.19	NA	NA
Heptachlor	<1.47	<1.33	<1.23	<1.28	<1.48	<1.48	<1.41	<1.23	NA	NA
Heptachlor epoxide	<1.45	<1.32	<1.20	<1.27	<1.47	<1.46	<1.39	<1.22	NA	NA
Methoxychlor	<26.0	<23.6	<21.6	<22.8	<26.3	<26.2	<25.0	<21.8	NA	NA
Toxaphene	<15.4	<13.9	<12.8	<13.5	<15.5	<15.5	<14.8	<12.9	NA	NA
Organotins (ug/kg)										
Tetrabutyltin	<1.56	<1.41	<1.29	<1.36	<1.57	<1.57	<1.49	<1.30	NA	NA
Tributyltin	<1.73	<1.57	<1.43	<1.51	<1.75	<1.74	<1.66	<1.45	NA	NA
Dibutyltin	<2.01	<1.82	<1.67	<1.76	<3.06	<2.02	<1.93	<1.69	NA	NA
Monobutyltin	<0.96	<0.87	<0.80	<0.84	<3.06	<0.97	<0.92	<1.30	NA	NA

< Indicates concentrations are less than the corresponding method detection limit (MDL)

ER-L = Effects Range- Low: Lower tenth percentile concentration of screened sediment toxicity data, at which toxicity may begin

ER-M = Effects Range-Median: Median concentration of a compilation of toxic samples. (Long 1995)

TABLE 16
Summary of *M. edulis* Water Column Toxicity Bioassay Results

Sample	Conc. (%)	Survival		Development	
		Mean % Survival	LC50 (%)	% Normal	EC50 (%)
Lab Control	-	90.0	NA	97.2	NA
Site Water	-	90.4	NA	96.3	NA
B1	10	92.2	> 100	97.4	> 100
	50	93.6		97.7	
	100	91.4		96.8	
B2	10	90.9	> 100	98.0	> 100
	50	94.6		97.4	
	100	90.7		96.9	
B3	10	92.9	> 100	96.7	> 100
	50	95.4		97.6	
	100	93.4		97.5	
B4	10	91.2	> 100	97.0	> 100
	50	93.1		97.1	
	100	89.8		96.9	
B5	10	95.0	> 100	97.7	> 100
	50	93.1		97.3	
	100	90.6		97.1	
B6	10	88.4	> 100	97.4	> 100
	50	91.2		97.6	
	100	86.7*		58.8*	
B7	10	94.4	> 100	96.7	> 100
	50	89.1		97.7	
	100	94.9		96.1	

* Statistically significant difference from the Site Water Control

Copper Sulfate Reference Toxicant				
Conc. (%)	Survival		Development	
	Mean % Survival	LC50 (µg/L)	% Normal	EC50(µg/L)
Control	95.3	15.136	97.5	7.519
2.5	88.1		92.2	
5.0	92.3		93.8	
10	86		4.9	
20	11.4		0	
40	0.1		0	

Laboratory Mean E/LC50 (µg/L):
Standard Deviation:
Sensitivity:

20.700
7.001
Normal

8.423
1.510
Normal

TABLE 17
Summary of *M. bahia* Water Column Toxicity Bioassay Results

Sample	Conc. (%)	Mean % Survival	LC50 (%)
Lab Control	-	100	NA
Site Water	-	100	NA
B1	10	100	> 100
	50	100	
	100	98.0	
B2	10	100	> 100
	50	100	
	100	100	
B3	10	100	> 100
	50	100	
	100	98.0	
B4	10	100	> 100
	50	98.0	
	100	96.0	
B5	10	100	> 100
	50	100	
	100	100	
B6	10	100	> 100
	50	98.0	
	100	98.0	
B7	10	100	> 100
	50	100	
	100	98.0	

Reference Toxicant					
Copper Sulfate Survival			Ammonia Survival		
Conc. (%)	Mean % Survival	LC50 (µg/L)	Conc. (%)	Mean % Survival	EC50(µg/L)
Control	100	222.133	Control	96.7	52.255
62.5	100		7.18	100	
125	100		14.3	100	
250	33.3		28.1	100	
500	16.7		55.3	43.3	
1000	3.3		106	0	

Laboratory Mean E/LC50 (µg/L):
Standard Deviation:
Sensitivity:

412.827
117.494
Normal

39.718
8.457
Normal

TABLE 18
Summary of *M. beryllina* Water Column Toxicity Bioassay Results

SAMPLE	Conc. (%)	Mean % Survival	LC50 (%)
Lab Control	-	100	NA
Site Water	-	98	NA
B1	10	100	> 100
	50	98	
	100	100	
B2	10	98	> 100
	50	94	
	100	100	
B3	10	98	> 100
	50	98	
	100	92	
B4	10	98	> 100
	50	98	
	100	86*	
B5	10	98	> 100
	50	100	
	100	98	
B6	10	100	> 100
	50	94	
	100	94	
B7	10	100	> 100
	50	100	
	100	98	

* Statistically significant difference from the Site Water Control

Reference Toxicants					
Copper Sulfate Survival			Ammonia Survival		
Conc. (%)	Mean % Survival	LC50 (µg/L)	Conc. (%)	Mean % Survival	EC50(µg/L)
Control	100	199.437	Control	96.7	26.229
25	96.7		2.96	100	
50	100		6.75	93.3	
100	96.7		14.1	83.3	
200	50		27.9	46.7	
400	0		57.1	0	

Laboratory Mean E/LC50 (µg/L):
Standard Deviation:
Sensitivity:

197.188
87.637
Normal

32.386
18.029
Normal

TABLE 19
Test Sediment Data Summary – *R. abronius*

Sample I.D.	% Survival (Mean ± SD)	% Reduction from Reference ^a	% Survival per Replicate				
			1	2	3	4	5
Control	95	-	85	100	100	95	95
LA-2	86	-	95	85	60	95	95
B1	33*	53	40	25	20	40	40
B2	26*	60	25	25	15	35	30
B3	35*	51	20	45	30	35	45
B4	26*	60	30	25	15	30	30
B5	37*	49	50	35	20	30	50
B6	40*	46	50	25	45	40	40
B7	38*	48	45	60	10	40	35

* Statistically significant difference from the Site Water Control

Reference Toxicant Results					
Cadmium			Ammonia		
Conc. (mg/L)	% Survival	LC50 (mg/L)	mg NH ₃ /L	% Survival	LC50 (mg/L)
Control	97	0.827	Control	97	69.58
0.125	100		16.2	90	
0.25	100		31.2	90	
0.50	80		60	80	
1.0	33		124	0	
2.0	0		220	0	

Laboratory Mean LC₅₀ (mg/L):
Standard Deviation:
Sensitivity:

0.752
0.334
Normal

78.62
17.92
Normal

TABLE 20
Test Sediment Data Summary – *N. arenaceodentata*

Sample I.D.	% Survival (Mean ± SD)	% Reduction from Reference ^a	% Survival per Replicate				
			1	2	3	4	5
Control	96	-	100	90	100	90	100
LA-2	98	-	100	100	100	90	100
B1	98	NA	100	90	100	100	100
B2	100	NA	100	100	100	100	100
B3	98	NA	100	100	90	100	100
B4	100	NA	100	100	100	100	100
B5	100	NA	100	100	100	100	100
B6	98	NA	100	100	100	90	100
B7	98	NA	100	90	100	100	100

NA = Not Applicable: Reference survival is lower than or equal to % survival results.

Reference Toxicant Results					
Cadmium			Ammonia		
Conc. (mg/L)	% Survival	LC50 (mg/L)	mg NH ₃ /L	% Survival	LC50 (mg/L)
Control	100	8.817	Control	80	126.95
3.75	100		17.6	93	
7.5	73		35.1	100	
15	0		63.6	100	
30	0		136	40	
60	0		250	0	

Laboratory Mean LC ₅₀ (mg/L):	10.531	105.50
Standard Deviation:	2.973	29.59
Sensitivity:	Normal	Normal

TABLE 21
Summary of Bioaccumulation Sediment Exposure Survival Results.

Sample ID	<i>Macoma nasuta</i> (% Survival)	<i>Nephtys caecoides</i> (% Survival)
Control	90.4	92.7
LA-2	96.0	87.7
B1	97.6	79.3
B2	96.8	83.3
B3	93.6	87.3
B4	92.8	86.0
B5	96.0	81.7
B6	95.2	81.0
B7	95.2	82.0

* Percent survival estimate based on initiation of test with 35 animals in replicate 1.

TABLE 22
Summary of Tissue Analysis for Bioaccumulation Tests with *M. nasuta* and *N. caecoides*

SAMPLE	SUBSTRATE	DDT (µg/Kg)	METALS (mg/kg)									
			Hg	Cd	Cr	Cu	Pb	Ni	Se	Ag	Zn	As
Background	Mn Tissue	<1.00	0.012	<0.100	<0.100	2.71	0.141	0.375	0.114	<0.100	12.0	2.30
	Nc Tissue	<1.00	0.024	0.190	0.641	6.83	0.138	0.919	0.886	<0.100	31.6	3.58
	Sediment	4.16	0.04	0.220	28.7	9.60	6.96	13.1	0.33	<0.15	50.8	3.59
LA-2 Reference	Mn Tissue	<1.00	0.011	<0.100	0.303	3.11	0.270	0.746	0.166	<0.100	16.0	3.20
	Nc Tissue	7.36	0.014	0.320	<0.100	3.66	0.206	0.616	0.691	<0.100	48.6	4.09
	Sediment	13.5	0.83	0.664	47.8	60.1	71.0	22.5	0.41	0.33	148	8.98
B1	Mn Tissue	7.58	0.018	<0.100	0.347	3.09	0.798	0.738	0.229	<0.100	16.4	2.61
	Nc Tissue	14.0	0.013	0.286	0.247	3.60	0.206	0.616	0.691	<0.100	48.6	4.09
	Sediment	11.7	0.36	0.747	41.5	49.2	72.1	18.9	0.37	0.34	135	6.05
B2	Mn Tissue	7.34	0.019	<0.100	0.307	3.68	0.802	0.725	0.258	<0.100	17.8	2.98
	Nc Tissue	9.62	<0.005	0.293	<0.100	3.47	0.255	0.689	0.648	<0.100	40.8	3.73
	Sediment	13.5	0.36	0.601	34.7	44.3	54.8	17.6	0.31	0.23	102	5.50
B3	Mn Tissue	8.27	0.018	<0.100	0.464	4.17	1.12	0.772	0.255	<0.100	20.9	2.90
	Nc Tissue	<1.00	<0.005	0.300	<0.100	3.33	0.269	0.577	0.606	<0.100	43.6	3.64
	Sediment	13.8	0.29	0.855	41.5	52.3	85.0	20.2	0.33	0.35	204	6.22
B4	Mn Tissue	7.80	<0.005	<0.100	0.344	2.99	0.829	0.719	0.179	<0.100	17.5	2.30
	Nc Tissue	11.6	0.008	0.269	<0.100	3.58	0.374	0.619	0.767	<0.100	42.6	3.77
	Sediment	12.5	0.31	0.901	50.8	56.0	97.9	22.7	0.47	0.46	155	7.33
B5	Mn Tissue	7.29	0.007	<0.100	0.330	3.28	0.817	0.615	0.132	<0.100	16.5	2.62
	Nc Tissue	12.1	0.005	0.294	0.111	4.48	0.399	0.705	0.816	<0.100	47.5	3.92
	Sediment	6.77	0.18	1.13	49.9	76.2	70.9	22.4	0.42	0.58	213	6.65
B6	Mn Tissue	<1.00	0.010	<0.100	0.187	3.09	0.431	0.908	0.358	<0.100	15.2	2.89
	Nc Tissue	23.2	0.005	0.325	0.110	4.98	0.284	0.679	0.462	<0.100	48.9	3.60
	Sediment	7.26	0.28	0.558	39.1	54.6	58.8	18.6	0.35	0.50	136	7.10
B7	Mn Tissue	6.89	0.015	<0.100	0.461	3.43	0.600	0.660	0.278	<0.100	16.5	2.74
	Nc Tissue	11.4	0.005	0.282	<0.100	4.24	0.278	0.684	0.746	<0.100	42.6	3.86

< Indicates concentrations are less than the corresponding method detection limit (MDL)

- DDT and heavy metals were measured in tissues exposed to project and reference sediments. However, since sediment contaminant levels were generally low, tissue concentrations following 28-day exposures were not expected to be elevated.
- Although the absence of sample replication prohibited statistical comparisons between contaminant concentrations detected project samples and those detected in the LA-2 reference sample, a review of the tissue composite data shows that the only contaminant detected at a level substantially higher than the LA-2 tissues was lead measured in *M. nasuta* tissues.
- However, this concentration (up to 1.12 mg/kg) is still below the tissue level of concern (2.8 mg/kg) as established by the Environmental Residue-Effects Database (ERED) generated by the U.S. Army Corps of Engineers (USACE 2005).

TABLE 23
Mean Survival Rate Summary for SP and BP Tests

Species	Sample Identification						
	B-1	B-2	B-3	B-4	B-5	B-6	B-7
<i>R. abronius</i> (%)	33	26	35	26	37	40	38
<i>N. arenaceodentata</i> (%)	98	100	98	100	100	98	98
<i>M. nasuta</i> (%)	98	97	94	94	97	95	94
<i>N. caecoides</i> (%)	79	83	87	85	81	83	81
<i>M. edulis</i> (LC50)	>100	>100	>100	>100	>100	>100	>100
<i>M. bahia</i> (LC50)	>100	>100	>100	>100	>100	>100	>100
<i>M. beryllina</i> (LC50)	>100	>100	>100	>100	>100	>100	>100

4 DISCUSSION

4.1 CHEMICAL AND PHYSICAL ANALYSIS OF TEST SEDIMENTS

- The metals copper, mercury and lead were detected at levels above ER-L values in most (exception of Hg in sample B6) AB Marina samples.
- Zinc was detected at levels above the ER-L value in samples B4, B5 and B6; and arsenic was detected above the ER-L in sample B1.
- With the exception of mercury detected in sample B1 (0.83 mg/kg), none of the measured metals exceeded more than 29% of the span between the ER-L and ER-M values.
- With the exception of DDT and negligible concentrations of PAH constituents, organic contaminants were not detected in AB Marina sediments.
- DDT concentrations was detected in the LA-2 reference sample at 4.16 µg/kg, and ranged from 6.77 to 13.8 µg/kg in AB Marina composite samples. Normalized to organic carbon content, the highest DDT concentration was 1.2 ppm OC. These values are higher than the ER-L, but below levels of significant concern as established by U.S. EPA Region IX, which determined that 7.5 ppm OC should be considered a site specific threshold for bioaccumulative concern for a harbor on the central coast of California (U.S. EPA 1998).

4.2 BIOASSAYS

- Significant toxicity was not observed with the polychaete SP or any of the three SPP tests
- The amphipod SP test using *Rhepoxinius abronius* exhibited significant toxicity among all AB Marina samples relative to the LA-2 reference treatments. This amphipod was selected based on previous performance in grain size profiles similar to those exhibited by the AB Marina sediments.
- Because the toxicity results do not vary significantly among the seven project samples ($\bar{x} = 34 \pm 5.6\%$), there is no significant correlation between contaminant concentrations or grain size constituents.
- Due to the high survival rates observed with each of the six other species tested with this study (see Table 24), generally low contaminant concentrations, and the absence of any correlation with any sediment constituents, these results may likely be anomalous.

4.3 BIOACCUMULATION STUDIES

- Due to the inadvertent compositing of the treatment tissue replicates, statistical analysis is not possible with the data currently available. Retesting has been initiated and tissue chemistry results will be provided as an addendum to this report.

4 DISCUSSION

4.1 CHEMICAL AND PHYSICAL ANALYSIS OF TEST SEDIMENTS

- The metals copper, mercury and lead were detected at levels above ER-L values in most AB Marina samples. Mercury measured in sample B6 was the one exception.
- Zinc was detected at levels above the ER-L value in samples B4, B5 and B6; and arsenic was detected above the ER-L in sample B1.
- With the exception of mercury detected in the Basin 1 sample (0.83 mg/kg), none of the measured metals exceeded more than 29% of the span between the ER-L and ER-M values.
- Mercury in the Basin 1 sample does not appear to exhibit bioaccumulative potential as the concentrations observed in the B1 composite tissue samples for both BP species were consistent with both the background (time = 0) and reference sediment tissues. If additional analyses are necessary to resolve the extent to which Basin 1 sediments exhibit higher mercury concentrations, results will be provided in an addendum to this report.
- With the exception of DDT and negligible concentrations of PAH constituents, organic contaminants were not detected in AB Marina sediments.
- DDT concentrations were detected in the LA-2 reference sample at 4.16 $\mu\text{g/kg}$, and ranged from 6.77 to 13.8 $\mu\text{g/kg}$ in AB Marina composite samples. Normalized to organic carbon content, the highest DDT concentration was 1.2 ppm OC. These values are higher than the ER-L, but below levels of significant concern as established by U.S. EPA Region IX, which determined that 7.5 ppm OC should be considered a site specific threshold for bioaccumulative concern for another coastal California harbor (USEPA 1998).

4.2 BIOASSAYS

- Significant toxicity was not observed with the polychaete SP or any of the three SPP tests
- The amphipod SP test using *Rhepoxinius abronius* exhibited significant toxicity among all AB Marina samples relative to the LA-2 reference treatments. This amphipod was selected based on previous performance in grain size profiles similar to those exhibited by the AB Marina sediments.
- Because the toxicity results do not vary significantly among the seven project samples ($\bar{x} = 34 \pm 5.6\%$), there is no significant correlation between contaminant concentrations or grain size constituents.
- The observed *R. abronius* survival rates contrast significantly with the high survival rates observed with each of the six other species tested under this study (see Table 24). Due to the absence of any significantly elevated contaminant concentrations, additional test procedures may be necessary to ascertain the relevance of the reduced *R. abronius* survival rates. Results of any additional testing will be provided in an addendum to this report.

4.3 BIOACCUMULATION STUDIES

- Due to the inadvertent compositing of the treatment tissue replicates, statistical analysis is not possible with the data currently available. Retesting has been initiated and tissue chemistry results will be provided as an addendum to this report.

TABLE 23
Mean Survival Rate Summary for SP and BP Tests

Species	Sample Identification						
	B-1	B-2	B-3	B-4	B-5	B-6	B-7
<i>R. abronius</i> (%)	33	26	35	26	37	40	38
<i>N. arenaceodentata</i> (%)	98	100	98	100	100	98	98
<i>M. nasuta</i> (%)	98	97	94	94	97	95	94
<i>N. caecoides</i> (%)	79	83	87	85	81	83	81
<i>M. edulis</i> (LC50)	> 100	> 100	> 100	> 100	> 100	> 100	> 100
<i>M. bahia</i> (LC50)	> 100	> 100	> 100	> 100	> 100	> 100	> 100
<i>M. beryllina</i> (LC50)	> 100	> 100	> 100	> 100	> 100	> 100	> 100

- DDT and heavy metals were measured in tissues exposed to project and reference sediments. However, since sediment contaminant levels were generally low, tissue concentrations following 28-day exposures were not expected to be elevated.
- Although the absence of sample replication prohibited statistical comparisons between contaminant concentrations detected project samples and those detected in the LA-2 reference sample, a review of the tissue composite data shows that the only contaminant detected at a level substantially higher than the LA-2 tissues was lead measured in *M. nasuta* tissues.
- However, the *M. nasuta* lead concentrations (up to 1.12 mg/kg) is still below the tissue level of concern (2.8 mg/kg) as established by the Environmental Residue-Effects Database (ERED) generated by the U.S. Army Corps of Engineers (USACE 2005).